The work environment of semiconductor fabricating plants is one of the safest in any industry. Measures taken to avoid contamination of the wafers lead to more than just antiseptically clean rooms: they result in a work environment nearly free of conditions that cause occupational illnesses and accidents.

Semiconductor fabricating plants operate around the clock. For this reason, night and weekend work is common. In some plants, workers maintain standard 8-hour shifts, 5 days a week. In other plants, employees work 12-hour shifts to minimize the disruption of clean room operations brought about by shift changes. Managers in some plants allow workers to alternate schedules for equitable distribution of the "graveyard" shift.

Employment

Electronic semiconductor processors held 63,000 jobs in 1998. Nearly all of them were employed in facilities that manufacture electronic components and accessories, though a small percentage worked in plants that primarily manufacture computers and office equipment.

Training, Other Qualifications, and Advancement

People interested in becoming semiconductor processors, either operators or technicians, need a solid background in mathematics and physical sciences. In addition to their application to the field, math and science knowledge are essentials for pursuing higher education in semiconductor technology—and knowledge of both subjects is one of the best ways to advance in the semiconductor fabricating field.

Semiconductor processor workers must also be able to think analytically and critically to anticipate problems and avoid costly mistakes. Communication skills are also vital, as workers must be able to convey their thoughts and ideas both orally and in writing.

A high school diploma or equivalent is the minimum requirement for entry-level operator jobs in semiconductor fabrication plants. Technicians must have at least an associate degree in electronics technology or a related field. Although completion of a 1-year certificate program in semiconductor technology offered by some community colleges is an asset, employers prefer to hire persons who have completed associate degree programs.

Degree or certificate candidates who get hands-on training while attending school look even more attractive to prospective employers. Semiconductor technology programs in a growing number of community colleges include an internship at a semiconductor fabricating plant; many students in these programs already hold full- or part-time jobs in the industry and work toward semiconductor technology in their spare time to upgrade or update their skills. In addition, to ensure that operators and technicians keep their skills current, most employers provide 40 hours of formal training annually. Some employers also provide financial assistance to employees who want to earn associate and bachelor's degrees.

Those who live near a semiconductor processing plant may have another option for getting started in the field: summer and part-time employment. Students often are hired to work during the summer, and some students are allowed to continue working part time during the school year. Students in summer and part-time semiconductor processor jobs learn what education they need to prosper in the field. They also gain valuable experience that may lead to full-time employment after graduation.

Some semiconductor processing technicians transfer to sales engineer jobs with suppliers of the machines that manufacture the semiconductors or become field support personnel.

Job Outlook

Between 1998 and 2008, employment of electronic semiconductor processors is projected to increase much faster than the average for all occupations. Besides the creation of new jobs, additional openings will result from the need to replace workers who leave the occupation. Growing demand for semiconductors and semiconductor processors will stem from the many existing and future applications for semiconductors in computers, vehicles, telecommunications, appliances, and other equipment.

The electronic components and accessories industry is projected to be one of the most rapidly growing manufacturing industries. Moreover, industry development of semiconductors made from better materials means that semiconductors will become even smaller, more powerful, and more durable. For example, the industry is researching a new generation of microchips, made with copper rather than aluminum wires, which will better conduct electricity. Also, technology to develop chips based on plastic, rather than on silicon, will make laptop computers durable enough to take to worksites where these computers could not easily have been used previously, such as construction sites. These technological developments will lead to new applications in commercial markets, resulting in employment growth in the industry.

Job prospects should be best for people with postsecondary education in electronics or semiconductor technology. Prospects should also be favorable for high school graduates with a strong science background, particularly for those who are willing to work toward a postsecondary degree while employed.

Earnings

Median hourly earnings of electronic semiconductor processors were $11.93 in 1998. The middle 50 percent earned between $9.76 and $14.25 an hour. The lowest 10 percent earned less than $8.43 and the top 10 percent earned more than $17.70 an hour.

Technicians with an associate degree in electronics or semiconductor technology generally started at higher salaries than those with less education.

Related Occupations

Electronic semiconductor processors do production work that resembles the work of precision assemblers of electrical and electronic equipment. Also, many electronic semiconductor processors have academic training in semiconductor technology, which emphasizes scientific and engineering principles. Other occupations that require some college or postsecondary vocational training emphasizing such principles are electrical and electronic technicians and science technicians.

Sources of Additional Information

For more information on semiconductor processor careers, contact:

☛ Semiconductor Industry Association, 4300 Stevens Creek Blvd., No. 271, San Jose, CA 95129.

☛ SEMATECH, 2706 Montopolis Dr., Austin, TX 78741. Internet: **http://www.4chipjobs.com**

☛ Maricopa Advanced Technology Education Center (MATEC), 2323 West 14th St., Suite 402, Tempe, AZ 85281. Internet: **http://matec.org**

Ophthalmic Laboratory Technicians

(O*NET 89917A and 89917D)

Significant Points

- Although some lenses are still produced by hand, technicians increasingly use automated equipment to make lenses.
- Nearly all ophthalmic laboratory technicians learn their skills on the job.
- The number of job openings will be low because the occupation is small and slow growth in employment is expected.

Nature of the Work

Ophthalmic laboratory technicians—also known as manufacturing opticians, optical mechanics, or optical goods workers—make prescription

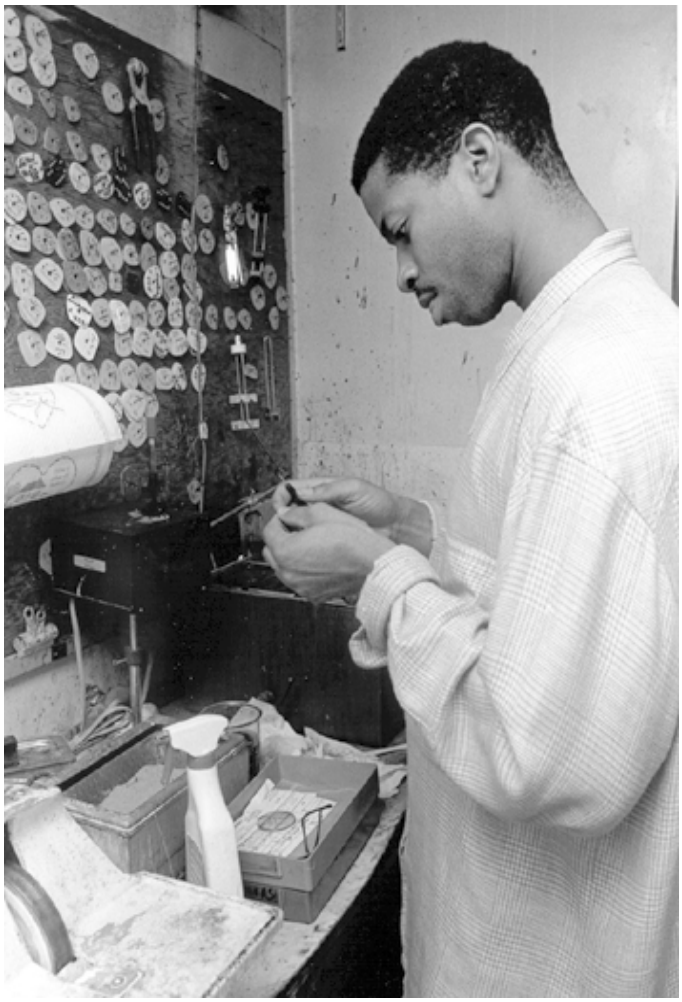
eyeglass lenses. Prescription lenses are curved in such a way that light is correctly focused onto the retina of the patient's eye, improving vision. Some ophthalmic laboratory technicians manufacture lenses for other optical instruments, such as telescopes and binoculars. Ophthalmic laboratory technicians cut, grind, edge, and finish lenses according to specifications provided by dispensing opticians, optometrists, or ophthalmologists, and may insert lenses into frames to produce finished glasses. Although some lenses are still produced by hand, technicians increasingly use automated equipment to make lenses.

Ophthalmic laboratory technicians should not be confused with workers in other vision care occupations. Ophthalmologists and optometrists are "eye doctors" who examine eyes, diagnose and treat vision problems, and prescribe corrective lenses. Ophthalmologists are physicians who perform eye surgery. Dispensing opticians, who may also do work described here, help patients select frames and lenses, and adjust finished eyeglasses. (See the statement on physicians, which includes ophthalmologists, and the statements on optometrists and dispensing opticians elsewhere in the *Handbook.*)

Ophthalmic laboratory technicians read prescription specifications, then select standard glass or plastic lens blanks and mark them to indicate where the curves specified on the prescription should be ground. They place the lens into the lens grinder, set the dials for the prescribed curvature, and start the machine. After a minute or so, the lens is ready to be "finished" by a machine that rotates it against a fine abrasive to grind it and smooth out rough edges. The lens is then placed in a polishing machine with an even finer abrasive, to polish it to a smooth, bright finish.

Next, the technician examines the lens through a lensometer, an instrument similar in shape to a microscope, to make sure the degree and placement of the curve is correct. The technician then cuts the lenses and bevels the edges to fit the frame, dips each lens into dye if the prescription calls for tinted or coated lenses, polishes the edges, and assembles the lenses and frame parts into a finished pair of glasses.

In small laboratories, technicians usually handle every phase of the operation. In large ones, technicians may be responsible for operating computerized equipment where virtually every phase of operation is automated. Technicians also inspect the final product for quality and accuracy.



Ophthalmic laboratory technicians make prescription eyeglass lenses.

Working Conditions

Ophthalmic laboratory technicians work in relatively clean and well-lighted laboratories and have limited contact with the public. Surroundings are relatively quiet despite the humming of machines. At times, technicians wear goggles to protect their eyes, and may spend a great deal of time standing.

Most ophthalmic laboratory technicians work a 5-day, 40-hour week, which may include weekends, evenings, or occasionally, some overtime. Some work part time.

Ophthalmic laboratory technicians need to take precautions against the hazards associated with cutting glass, handling chemicals, and working near machinery.

Employment

Ophthalmic laboratory technicians held about 23,000 jobs in 1998. Thirty-three percent were in retail optical stores that manufacture and sell prescription glasses. A little over 31 percent were in optical laboratories. These laboratories manufacture eyewear for sale by retail stores that fabricate prescription glasses, and by ophthalmologists and optometrists. Most of the rest were in wholesalers or in optical laboratories that manufacture lenses for other optical instruments, such as telescopes and binoculars.

Training, Other Qualifications, and Advancement

Nearly all ophthalmic laboratory technicians learn their skills on the job. Employers filling trainee jobs prefer applicants who are high school graduates. Courses in science, mathematics, and computers are valuable; manual dexterity and the ability to do precision work are essential.

Technician trainees producing lenses by hand start on simple tasks such as marking or blocking lenses for grinding, then progress to lens grinding, lens cutting, edging, beveling, and eyeglass assembly. Depending on individual aptitude, it may take up to 6 months to become proficient in all phases of the work.

Technicians using automated systems will find computer skills valuable. Training is completed on the job and varies in duration depending on the type of machinery and individual aptitude.

Some ophthalmic laboratory technicians learn their trade in the Armed Forces. Others attend the few programs in optical technology offered by vocational-technical institutes or trade schools. These programs have classes in optical theory, surfacing and lens finishing, and the reading and applying of prescriptions. Programs vary in length from 6 months to 1 year, and award certificates or diplomas.

Ophthalmic laboratory technicians can become supervisors and managers. Some technicians become dispensing opticians, although further education or training is generally required.

Job Outlook

Overall employment of ophthalmic laboratory technicians is expected to grow more slowly than average through the year 2008. Employment is expected to increase slowly in manufacturing as firms invest in automated machinery. In retail trade, employment is expected to decline.

Demographic trends make it likely that many more Americans will need vision care in the years ahead. Not only will the population grow, but also the proportion of middle-aged and older adults is projected to increase rapidly. Middle age is a time when many people use corrective lenses for the first time, and elderly persons require more vision care, on the whole, than others.

Fashion, too, influences demand. Frames come in a variety of styles and colors—encouraging people to buy more than one pair. Demand is also expected to grow in response to the availability of new technologies that improve the quality and look of corrective lenses, such as anti-reflective coatings and bifocal lenses without the line visible in traditional bifocals.

Most job openings will arise from the need to replace technicians who transfer to other occupations or leave the labor force. Only a small number of total job openings will occur each year because the occupation is small.

Earnings

Median hourly earnings of ophthalmic laboratory technicians were $9.39 in 1998. The middle 50 percent earned between $7.56 and $11.58 an hour. The lowest 10 percent earned less than $6.48 and the highest 10 percent earned more than $15.74 an hour. Median hourly earnings of ophthalmic laboratory technicians in 1997 were $8.60 in ophthalmic goods and $8.30 in retail stores, not elsewhere classified.

Related Occupations

Workers in other precision production occupations include biomedical equipment technicians, dental laboratory technicians, orthodontic technicians, orthotics technicians, prosthetics technicians, and instrument repairers.

Sources of Additional Information

For general information about a career as an ophthalmic laboratory technician and a list of accredited programs in ophthalmic laboratory technology, contact:

☛ Commission on Opticianry Accreditation, 10111 Martin Luther King, Jr. Hwy., Suite 100, Bowie, MD 20720-4299.
Internet: **http://www.coaccreditation.com**

Painting and Coating Machine Operators

(O*NET 92947, 92951, and 92953)

Significant Points

- Most workers acquire their skills on the job; for most operators, training lasts from a few days to several months, but becoming skilled in all aspects of automotive painting usually requires 1 to 2 years.
- Slower-than-average growth is projected through 2008, but job prospects should be favorable.

Nature of the Work

Millions of items ranging from cars to candy are covered by paint, plastic, varnish, chocolate, or some other type of coating solution. Often the protection provided by the paint or coating is essential to the product, as with the coating of insulating material covering wires and other electrical and electronic components. Many paints and coatings have dual purposes, such as the paint finish on an automobile, which heightens the visual appearance of the vehicle while providing protection from corrosion.

Painting and coating machine operators control the machinery that applies these paints and coatings to a wide range of manufactured products. Perhaps the most straightforward technique is simply dipping an item in a large vat of paint or other coating. This is the technique used by *dippers*, who immerse racks or baskets of articles in vats of paint, liquid plastic, or other solutions using a power hoist. Similarly, *tumbling barrel painters* deposit articles made of porous materials in a barrel of paint, varnish, or other coating, which is then rotated to insure thorough coverage.

Another familiar technique is spraying products with a solution of paint or other coating. *Spray-machine operators* use spray guns to coat metal, wood, ceramic, fabric, paper, and food products with paint and other coating solutions. Following a formula, operators fill the equipment's tanks with a mixture of paints or chemicals, adding prescribed amounts of solution. They adjust nozzles on the spray guns to obtain the proper dispersion of the spray and hold or position the guns to direct the spray onto the article. Operators also check the flow and viscosity of the paint or solution and visually inspect the quality of the coating. When products are drying, these workers must often regulate the temperature and air circulation in drying ovens.

Painting and coating machine operators use various types of spray machines to coat a range of products. Often, their job title reflects the specialized nature of the machine or the coating being applied. For example, *enrobing machine operators* coat, or "enrobe," confectionery, bakery, and other food products with melted chocolate, cheese, oils, sugar, or other substances. *Paper coating machine operators* spray "size" on rolls of paper to give it its gloss or finish. And *silvering applicators* spray silver, tin, and copper solutions on glass in the manufacture of mirrors.

In response to concerns about air pollution and worker safety, manufacturers increasingly use new types of paints and coatings on their products instead of high-solvent paints. Water-based paints and powder coatings are two of the most common. These compounds do not emit as many volatile organic compounds into the air and can be applied to a variety of products. Powder coatings are sprayed much like liquid paints and then heated to melt and cure the coating.

The adoption of new types of paints is often accompanied by a conversion to more automated painting equipment that the operator sets and monitors. When using these machines, operators position the automatic spray guns, set the nozzles, and synchronize the action of the guns with the speed of the conveyor carrying articles through the machine and drying ovens. The operator may also add solvents or water to the paint vessel that prepares the paint for application. During operation, these workers tend painting machines, observe gauges on the control panel, and randomly check articles for evidence of any variation from specifications. The operator then uses a spray gun to "touch up" spots where necessary.

Although the majority of painting and coating machine operators are employed in manufacturing, the best known group of these workers refinish old and damaged cars, trucks, and buses in automotive body repair and paint shops. *Automotive painters* are among the most highly skilled manual spray operators because they perform intricate, detailed work and mix paints to match the original color, a task that is especially difficult if the color has faded.

To prepare a vehicle for painting, automotive painters or their helpers use power sanders and sandpaper to remove the original paint or

A painting and coating machine operator carefully prepares a car before painting.